



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Relative Scales of Hydrodynamic and Geomorphologic Influence on the Hydrologic Response in the Illinois River Basin

Focus Categories: G&G, HYDROL, FL

Keywords: Geomorphology, channels, watershed management, hydrologic models

Duration: August 15, 1999 to August 14, 2001

Federal Funds Requested: \$19,752

Non-Federal Matching Funds: \$40,630

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Congressional District: 15th

Statement of Critical Regional or State Water Problems

The Illinois River has been the focus of considerable interest within the state, and one of the main concerns has been the impact of human activity on the hydrological regime of the river [Kustra, 1997]. Interest has centered specifically on the effect of altered hydrologic regimes on floodplain ecosystems [Sparks, 1992]. Along with the human impacts, the integrated effects of climate, geology, land use, physiography and geomorphology determine the hydrologic regime through the quality and quantity of water, sediment and other constituents transported through the river system. Basin geomorphology along with other controls such as hydraulics, water quality, dams, vegetation and habitat characteristics plays a central role in determining the ecological health of the watershed. Consequently the "1997 Integrated Management Plan" [Kustra, 1997] calls for the evaluation of alternative management strategies, and supports several model studies that consider the integrated impact of multiple watershed factors.

Flow through the river system exhibits different characteristics at various scales from small headwater streams to major rivers. Low order streams near the headwater are typically characterized by moderate to steep slopes and are the primary conduits of water and sediment to higher order streams. In higher order streams, gradient decreases, channels widen, transport of large sediment decreases while total volume of sediment increases. It is increasingly being recognized that addressing the "issue of scale", i.e., understanding and determining the dominant controlling factors at various scales, is of fundamental importance in developing appropriate policy decisions on watershed management. Recent theories [Rinaldo et al., 1991] have suggested that as basin size increases the river network structure masks the effect of differences in hydrodynamic conditions in individual channel reaches. This effect of network structure, referred to as

geomorphologic dispersion, plays an important role in the prediction of transport phenomena. The aim of the proposed work is to determine the relative effects of geomorphological dispersion and hydrodynamic dispersion on the hydrological response of the Illinois River system. A particular area of focus will be to examine the effects of two human actions - modification of network structure via land drainage activities and construction of dams - on contemporary hydrological conditions. The results will provide important information and predictive capabilities for assessing the influence of future management scenarios on the hydrology of the Illinois River.

Statement of Results or Benefits

Modeling of the movement of water and sediment is an essential activity for effective watershed management and decision-making. The mechanisms contributing to the movement of water includes the heterogeneity of flow resistance throughout the channel system (hydrodynamic dispersion) and the topological structure of the channel system (geomorphologic dispersion). Proper assessment of the relative influence of these two mechanisms on hydrological response is important because it allows management efforts at different scales to be directed toward the mechanism that is most influential at these scales. It also provides information on the relative effectiveness of specific management options on the overall hydrological response of the basin. This type of analysis can improve the overall cost efficiency of watershed management.

Objectives of the Research

The objective of the proposed work is to determine the relative effects of geomorphological dispersion and hydrodynamic dispersion on the hydrological response of the Illinois River system as scale increases. The specific hypothesis to be tested is that as basin size increases, the river network structure, as compared to channel hydrodynamic properties, plays an increasingly dominant role in determining the hydrological response. The research will also explore the effects of two human actions - modification of network structure via land drainage activities and construction of dams - on contemporary hydrological conditions. Whereas dams have undoubtedly had an important influence on hydrodynamic dispersion, the exact nature of this influence at different scales remains unknown. Moreover, the addition of headwater tributaries through land drainage activity in the late 1800s has undoubtedly greatly modified geomorphological dispersion, but the influence of this activity is also unknown. The results will provide important information and predictive capabilities for assessing the influence of future management scenarios on the hydrology of the Illinois River.